



## Norfolk Flooding Strategy Overview

# Norfolk Flooding Strategy

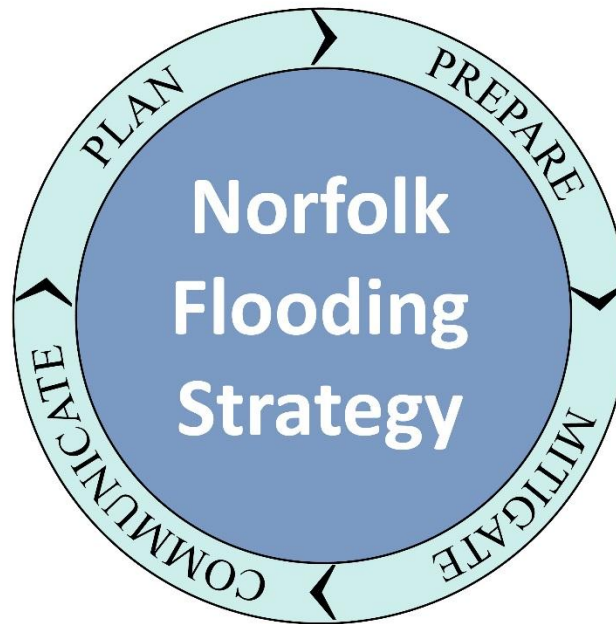
- Over the course of the past three years, the City has undertaken a comprehensive approach to address precipitation and tidal flooding across the entire City.
- Realizing the magnitude by which we must address this issue, our work plan has evolved into a four-pronged strategy.

## Plan

- City planning
- Study and analysis
- Modeling & simulation

## Communicate

- Citizen outreach
- Partnerships
- Online resources



## Prepare

- Emergency Preparedness & Response
- Education & Training

## Mitigate

- Infrastructure development
- Flood remediation and mitigation

# COLONY OF VIRGINIA



Scale 0 100 200 300 400 500 feet



Survey September 20th 1682

NORFOLK COUNTY established 1682

DUN IN THE MIRE 1682

MAIN BRANCH ELIZABETH RIVER 1682



Bureau of Surveys, Norfolk, Virginia  
compiled by Grover Franklin  
drawn by Lionel P. Brown

## Royal Governors:

Thomas, second Lord Culpeper, Baron Thersway,  
Governor and Captain General, 1671-1675.  
Sir Henry Chicheley, Deputy Governor,  
1675-1676.  
Francis, Lord Howard of Effingham,  
Governor, 1676-1677.  
Edward Mordaunt, 1677-1678.  
Sir Edmund Andros, 1678-1682.  
James and Captain-General, 1682-1683.  
George Hamilton Douglas, Earl of Orkney,  
Governor in Chief, 1683.

## Annual Fair:

The Fifth Day of October and a days  
following, Elizabeth of Sunday.

## Market Days:

Tuesday and Saturday

first EASTERN BRANCH

## ORIGINAL 50 ACRES

held and conveyed by Nicholas Mott,  
Wharfedale, to Mott, William, William  
and William Mott, of Norfolk, in 1682.  
The Mott family has been in Norfolk  
since 1682, and in the 16th year of the  
 reign of our sovereign, King Charles the  
 Second, our English, Scottish, English and  
 Ireland, defender of the Faith, &c.

Nich. X. Mott and Son  
Mott

65 75 by Miles  
1782



Norfolk town

Lieut. Governor, County Surveyor, 1682-83



## NORFOLK'S ORIGINAL FIFTY ACRES



John Ferebee, County Surveyor 1680 - 1681  
John Ward, City Surveyor 2006 - Present

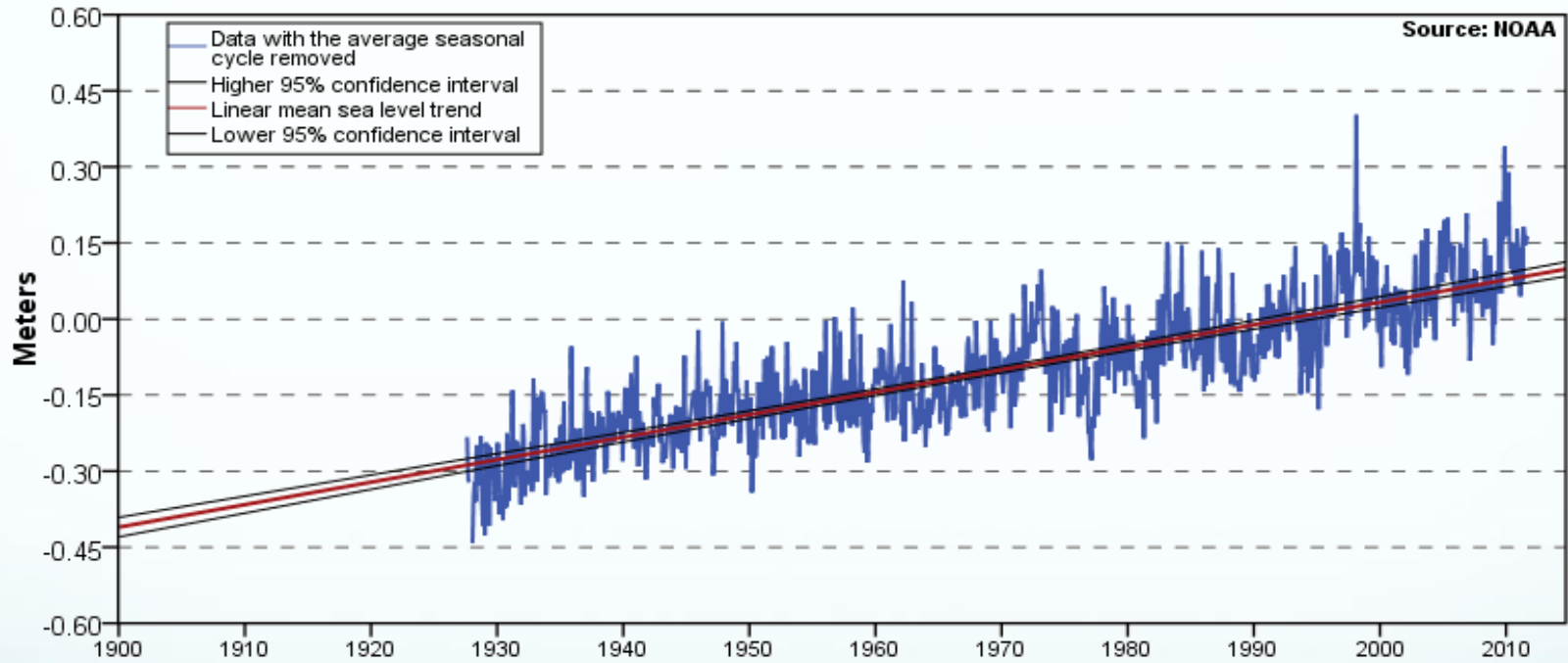


This map depicts the original fifty acres of Norfolk overlaid upon 2013 imagery. This was created in multiple steps.  
First, the original "Norfolk Towne, 50 Acres, 1682" map was scanned.  
Next, city staff consulted with local historians to determine sites that still exist today.  
Then, field crews were sent out to collect GPS coordinates on the previously determined locations.  
Finally, the scanned image was georeferenced to the GPS points  
and the fifty acre boundary was digitized by a city technician.  
2013 Imagery is property of Pictometry International.  
Map compiled October 2008, Updated 2013.  
This map is for graphic purposes only.



Sewells Point, VA

4.44 +/- 0.27 mm/yr







# Engineering Basics – Living in the “Tidewater”



In the low-lands of Coastal Virginia rainfall runoff is typically hindered by flat topography and old infrastructure



Tidal Surge (&/or future SLR) reduces the gradient and slows transport of runoff, worsening flooding

**IMPLICATION:** Tidal Surge (&/or future SLR) both directly cause inundation and delay runoff from rainfall - thus worsening & extending the duration of storm flooding.

**TYPICAL SUBMERGED OR PARTIALLY SUBMERGED STORM WATER OUTFALL**

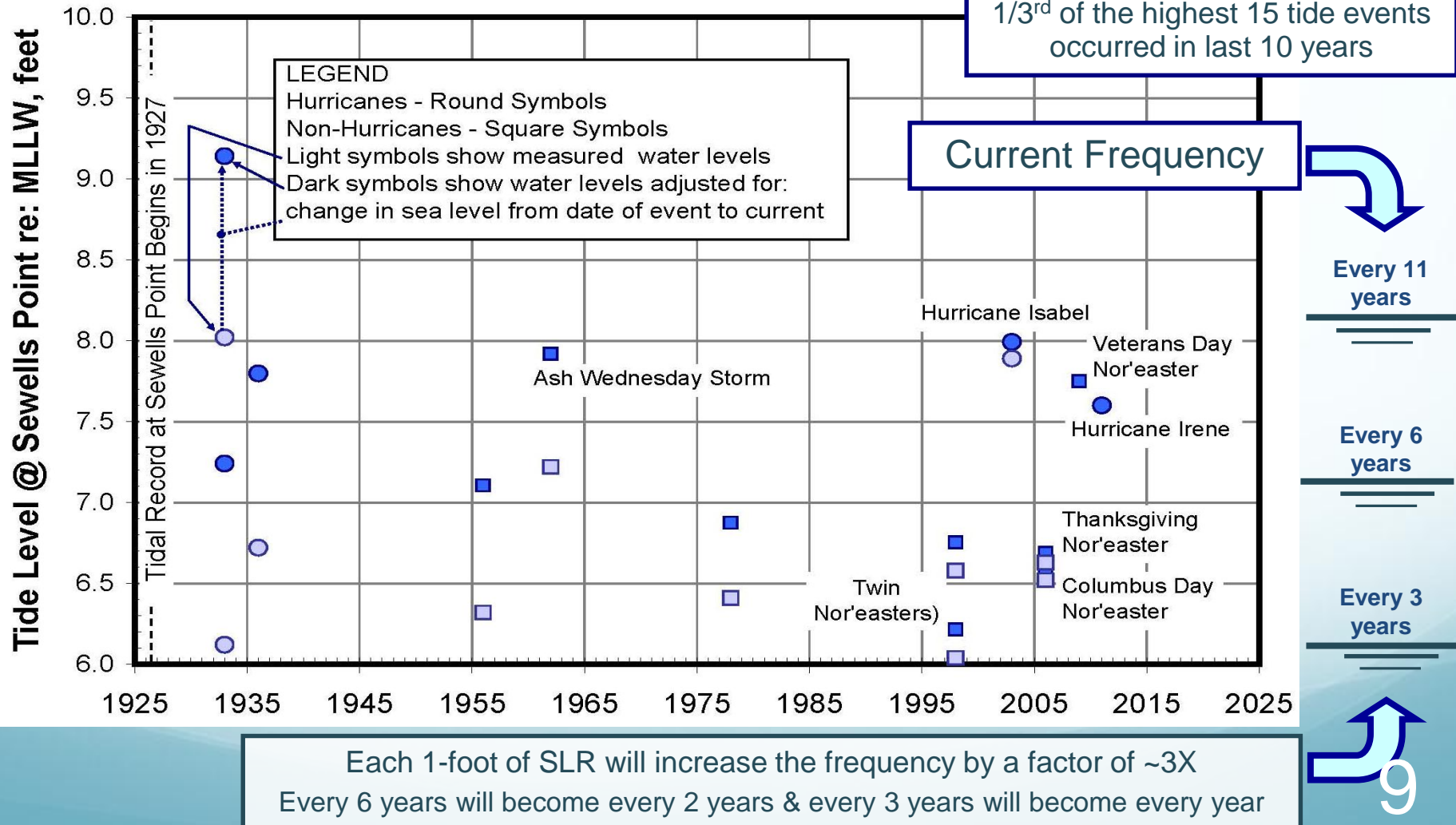
Tailwater phenomena causes rainfall and tidal flooding to be inextricably linked.

Tail Water Elevation

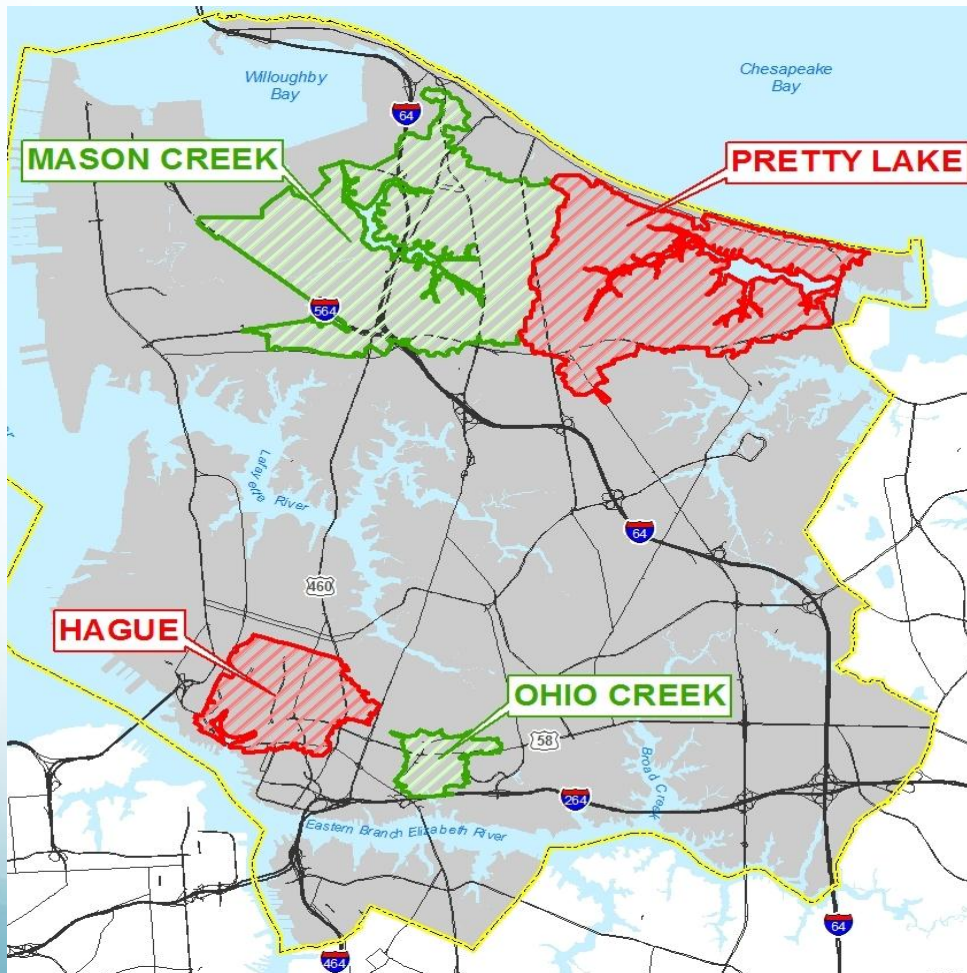


# Highest Recorded Tide Events at Sewells Point

- The Sewells Point Tide gauge provides the longest records along the US East Coast



# Norfolk Coastal Flooding Study: Initial Focus



## Choices based on:

- Geographic setting areas with narrow tidal mouths (natural constriction points)
- Watersheds which were expected to lend themselves to specific, basin-wide mitigation options (simpler cases)
- Areas of recurring damage

# Coastal Flooding Study: Citywide Report

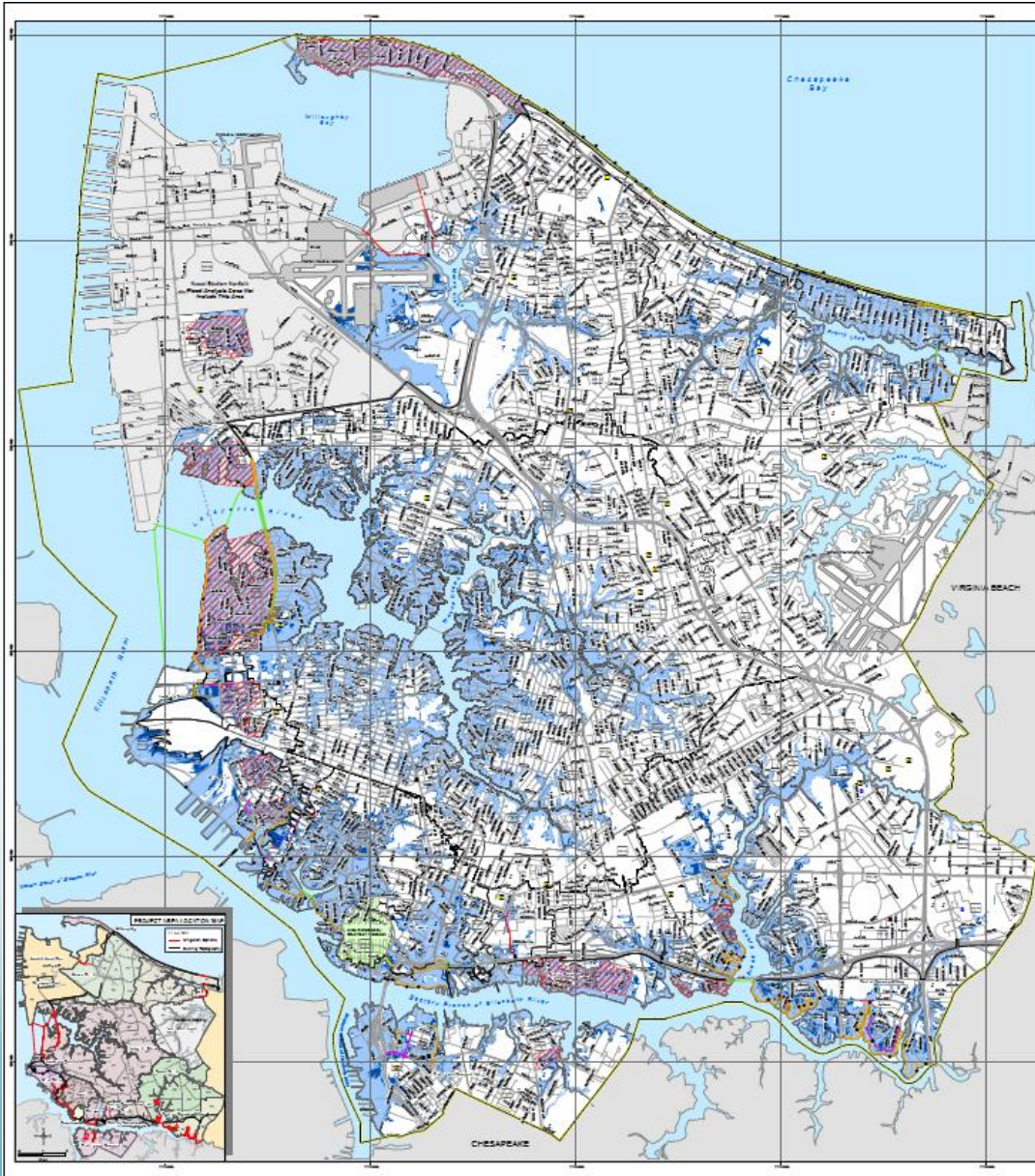
- This study performed by Fugro Atlantic builds upon previous phases of work and identifies flood mitigation options throughout the City.
- Using various water levels, a GIS-based model was developed to predict coastal flooding extents and depths throughout the City.
- Flood mitigation concepts identified include policy, education, building codes, elevation of buildings and roadways, and infrastructure.





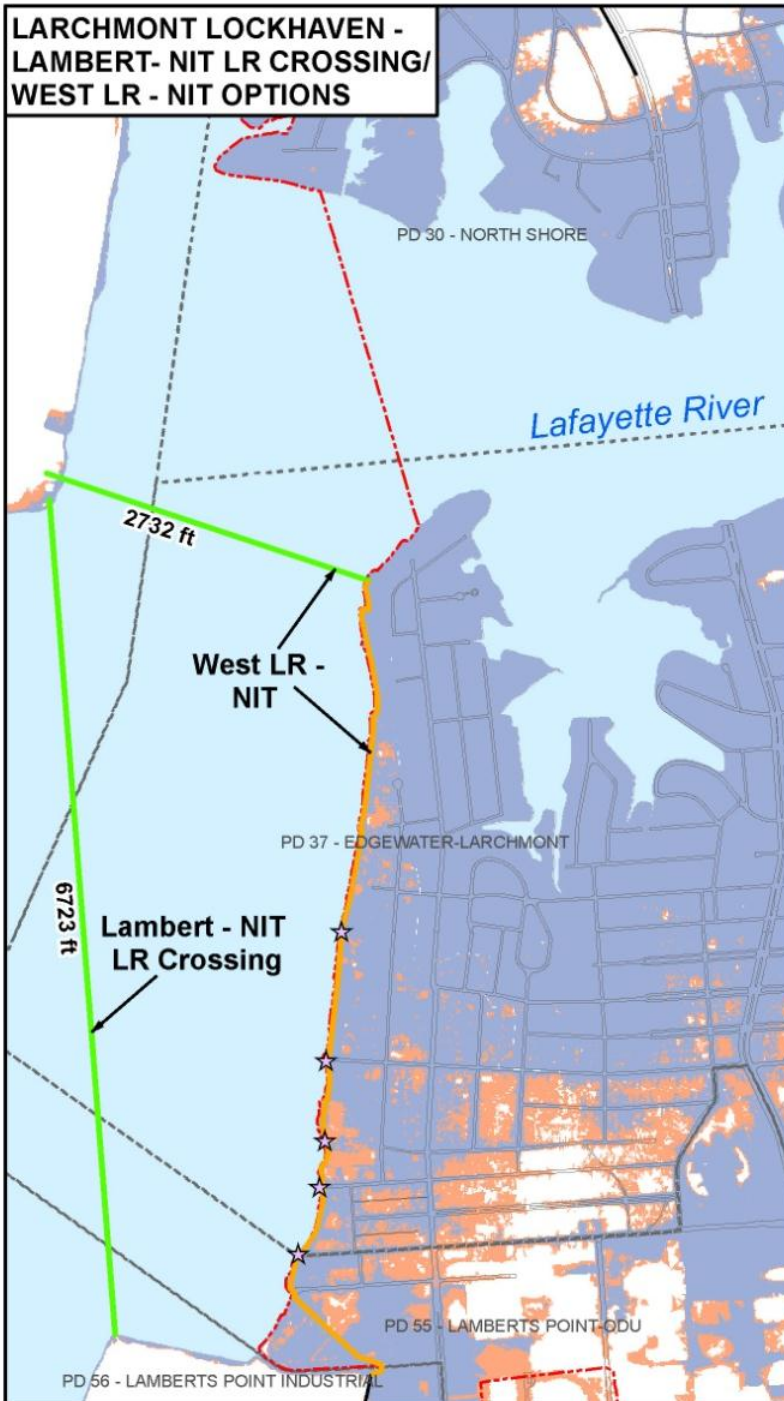


# Coastal Flooding Study: Summary



- 15 project areas were identified totaling over \$300 M
- Options generally include a flood barrier system across the basin outlet and for areas outside the barrier, elevating structures or floodproofing is recommended
- The most extensive project option identified is the Lafayette River watershed which comprises 26% of the City's land mass
  - The Lafayette River and Tidewater areas were identified for potential multi-use projects that could incorporate a combination of flood mitigation infrastructure and transportation or recreational facilities (ie roads, rail, bike paths, etc.)

LARCHMONT LOCKHAVEN -  
LAMBERT- NIT LR CROSSING/  
WEST LR - NIT OPTIONS



# Coastal Flooding Mitigation Option: Lafayette River Project Area

- Project area is 26% of City's total area
- 48,259 acres with 22,838 houses and non-residential buildings
- History of severe flooding and repetitive loss claims predicted to account for 49% of total damages citywide.
- Minimum project costs estimates range from \$175 M - \$300 M

## Mitigation Options

- |   |                    |
|---|--------------------|
| Road Raise  | House Raising      |
| Berm  | Outfall Flap Valve |
| Flood Gate  | Pump Station       |
| Floodwall   |                    |
| Culvert   |                    |
| Existing Floodwall  |                    |
| Existing Topography   |                    |
| Feature with Yellow Highlight Required for 1-foot of Sea Level Rise |                    |

## LEGEND

- |  |
|--|
| Project Area   |
| Planning District Boundary   |
| <b>Approximate Coastal Flooding</b><br>Does not include precipitation. |
| 1% Annual Chance Coastal Flood Extent                                  |
| 1% Annual Chance Coastal Flood Extent with 1-Foot Sea Level Rise       |



# Precipitation Flooding Study & Drainage Master Plan



- Precipitation Drainage Master Plan finalized by Timmons Group in November 2012
- Analyzed 253 city stormwater drainage watersheds
- Developed a Quantifiable Scoring (Prioritization) System
- Analysis aggregated into Planning Districts

# **Precipitation Flooding Study: Summary**

- **It was determined that 17% of road miles in the City require drainage and roadway improvements**
- **A total of 445 project areas were identified within the 87 planning districts**
- **The total estimated costs range from \$550 M - \$770 M**

# Progress of Studies by the US Army Corps of Engineers

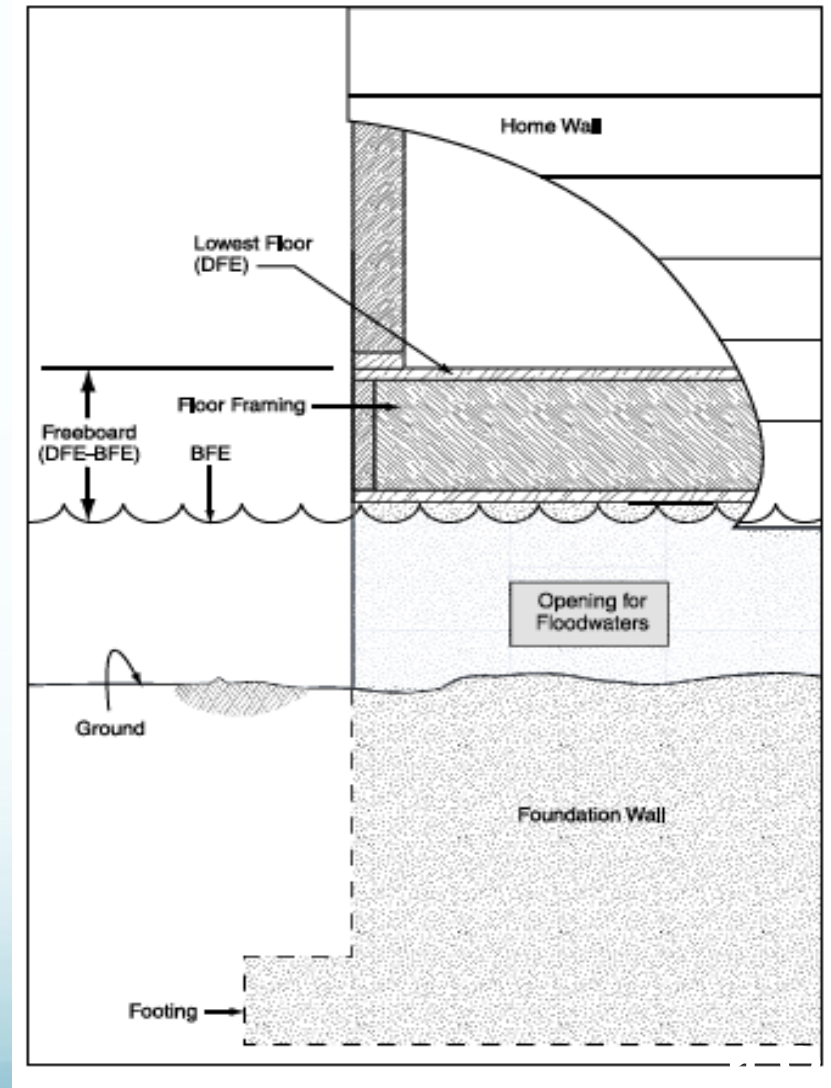
- After a decade of study, the General Reevaluation Report for the Ocean View beaches is complete.
  - The total estimated construction costs for a protective berm totals \$18.4 million and Norfolk's share is estimated just below 30% at \$5.5 million.
- Hague and Pretty Lake Reconnaissance Studies are nearly complete and the projects will likely move on to the Feasibility phase under the Section 205 Continuing Authorities Program.
- Approval is pending for a comprehensive citywide study of Norfolk under the Hurricane Sandy Comprehensive Relief Bill



# Development Standards and Procedural Changes

New development requirements have been adopted and procedural changes to enhance flood resilience for properties which in turn will lower insurance rates.

The new standard is 3 feet above base flood elevation.




# Brambleton Mitigation Project Underway

\$2.4 M project will raise westbound lanes to reduce frequency of flooding and provide enhanced access to Fort Norfolk and the Medical Complex







# Communication Activities



**NORFOLK**  
Life, Celebrated Daily. *Virginia*







GOVERNMENT | BUSINESS | SERVICES | COMMUNITY | ENJOY NORFOLK | HOW DO I

Internal City Structure | Tools for Growth | Provided by the City | Resident Engagement | Leisure & Visitors | Information Center



## FLOODING AWARENESS & MITIGATION

A to Z Ask a Question Departments



Flooding Awareness Meeting Agenda 6-20

Brochures

FEMA Mitigation Links

Flood Insurance

Hazard Mitigation Assistance (HMA)

Flood Zones/Regulations

Flood Prone Areas

Flooding CIP Projects

Flooding Strategy

Homeowner's Role

Home > Community > Flooding Awareness & Mitigation

[A](#) [A](#) [A](#)

### Flooding Awareness & Mitigation

#### Flood Awareness

Like any other low lying coastal area, Norfolk's elevation and its proximity to the Chesapeake Bay and several rivers make it susceptible to flooding. Nearly every year, and sometimes several times throughout the year during periods of heavy rain, hurricanes or nor'easter storms, residential and commercial properties are threatened with the potential of precipitation, tidal and/or wind-driven flooding and/or low-land flooding, particularly in neighborhoods around Norfolk's many waterways.

#### Common Flooding Types and Definitions

- **Precipitation Flooding** - Occurs when rain intensity exceeds capacity of our storm drain systems due to blockages or naturally depressed elevations.
- **Storm Flooding** - Is caused by storm surges resulting from events such as hurricanes and nor'easters and is directly related to land elevation and proximity to coastline. High tides magnify this storm damage.
- **Tidal Flooding** - Is caused by tidal variations and is directly related to land elevation and proximity to coastline. Tidal flooding may occur on a regular basis due to normal moon cycles and is exacerbated by wind speeds and directions, sea level rise, and other types of flooding.

#### Flood Mitigation

#### CONTACT US

Flooding Information  
757-823-4000  
[Email](#)

#### QUICK LINKS

- FEMA Flood Maps, Insurance, and Information
- Federal Alliance for Safe Homes
- Flood Smart-Flood Insurance
- Flooding Terms
- Storm-wise Tips

[VIEW ALL](#)

#### FAQs

- What can you do about street flooding?
- Do I need flood insurance?
- What is the difference between a firm map and a surge map?

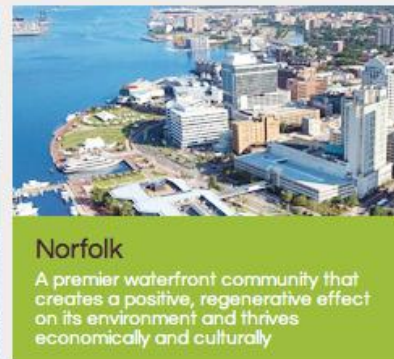
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# Seeking Private Sector Investment



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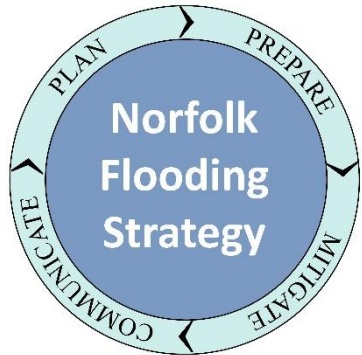


## Norfolk

A premier waterfront community that creates a positive, regenerative effect on its environment and thrives economically and culturally

Re.invest Initiative cities include: El Paso, Hoboken, Honolulu, Miami, Milwaukee, New Orleans, Norfolk and San Francisco

# Seeking Private Sector Investment



Alameda, California, USA  
Berkeley, California, USA  
Boulder, Colorado, USA  
El Paso, Texas, USA  
Jacksonville, Florida, USA  
Los Angeles, California, USA  
New Orleans, Louisiana, USA  
New York City, New York, USA  
Norfolk, Virginia, USA  
Oakland, California, USA  
San Francisco, California, USA

Medellin, Colombia  
Mexico City, Mexico  
Porto-Alegre, Brazil  
Quito, Ecuador  
Rio de Janeiro, Brazil  
Bristol, UK  
Glasgow, UK  
Rome, Italy  
Rotterdam, Netherlands  
Vejle, Denmark  
Ashkelon, Israel

Byblos, Lebanon  
Ramallah, Palestine  
Dakar, Senegal  
Durban, South Africa  
Bangkok, Thailand  
Da Nang, Vietnam  
Mandalay, Myanmar  
Semarang, Indonesia  
Surat, India  
Christchurch, New Zealand  
Melbourne, Australia



# NATIONAL INSTITUTE FOR COASTAL & HARBOR INFRASTRUCTURE

## Mission Statement

[www.NICHIUSA.org](http://www.NICHIUSA.org)

- The National Institute for Coastal and Harbor Infrastructure is nonprofit entity established to advocate for an expanded federal role in coastal climate adaptation.
- Our national economy and our national security are imperiled by the triple threat of rising sea levels, extreme weather events and aging infrastructure.
- Our choice is clear. We can either respond to the magnitude and urgency of this crisis with a continuing cycle of local and regional disaster relief, repairing our 20th Century infrastructure at great cost in lives and property, or we can develop and fund a national program to assist our cities and states in the cost effective implementation their climate adaptation plans, protecting our communities while revitalizing our coastal economies with state of the art technology, innovative transportation systems, modern port facilities and non infrastructure solutions.
- NICHI is committed to building a broad national coalition of private and public interests to advocate for a national interstate coastal infrastructure system that integrates, enhances and funds local, regional and state coastal climate adaptation plans.
- William B. Golden is a former Massachusetts State Senator who has participated in the creation of the United States EPA, NOAA, The Massachusetts Water Resources Authority, the Urban Harbors Institute and Save the Harbor Save the Bay and rode out Super Storm Sandy in New York aboard the Nantucket Lightship (WLV612).



# How Unique was Sandy?

- Track-line Plot of Tropical Storms, Hurricanes and Superstorms since 2000
- Sandy was unusual, but not unique
- Many believe (and the a study by the Virginia Institute of Marine Sciences suggests) that Sandy is a forerunner of the future and not a one-of event

